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Peak Flow Meter Equipped with Inspection Results Indicator

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Abstract— Peak Flow Meter (PFM) is a tool to measure the Peak Flow of air expiration in the road (PFR) or commonly referred to as Peak Expiration Flow (PEF) and to connect asthma. The value of PEF can help a number of factors in age, respiratory muscle strength, height, and gender. Airway measurements are used to measure patients suffering from asthma. This peak flow meter tool works based on the air pressure produced from the patient's puff using the MPX5100GP pressure sensor in the range of 0 to 100 kPa and the voltage output is 0.2 to 4.7 VDC to increase wind pressure in the patient. From the pressure converted to voltage and enter the 0 from the Arduino nano minimum system circuit to be processed into analog data and then put into units of liters/second, the value of the flow meter is sent and replaced to a PC with the Delphi7 application. The measurement results of PEF values at peak flow meters have an error value of less than 5% This peak flow meter tool also has a considerable value of 0.095475 so that this tool can be said to be very certain to be used as asthma. Then it can be concluded that the peak flow meter is feasible and meets the specified requirements

Keywords—Peak Flowmeter; MPX5100; Asthma

I. INTRODUCTION

Peak flow meter (PFM) is a tool used to measure the value of the highest breath power or the ability of a person to blow air from inside the lungs. This value is obtained from the best peak flow value that can be achieved by the patient so that it can identify the presence and level of respiratory obstruction. The value of the peak flow rate (PEFR) can be influenced by several factors, namely age, height and gender[1]. Riset Kesehatan Dasar (RISKEDAS) in Indonesia in 2013 found the national prevalence of asthma at all ages was 4.5%. The highest prevalence of asthma is found in Central Sulawesi (7.8%), followed by East Nusa Tenggara (7.3%), Yogyakarta Special Region (6.9%), and South Sulawesi (6.7%). Central Java Province has an asthma prevalence of 4.3%. He also said that the prevalence of asthma was higher in women compared to men. The prevalence of asthma in children aged 13-14 years in Semarang is 7.1%. According to the World Health Organization (WHO) in 2004 lung disease was among the 10 causes of death in the world including Chronic Obstructive Pulmonary Disease (COPD) (5.1%), pulmonary TB (2.5%), and lung cancer (2.3%) Based on the Household Health Survey (SKRT) of the Indonesian Ministry of Health in 1992, chronic obstructive pulmonary disease with bronchial asthma was ranked sixth [2]. According to the Global Initiative for Asthma (GINA), asthma is a major public health problem in all countries in the world and there are 300 million people with asthma worldwide and is expected to continue to increase to 400 million by 2025. One in 250 people who die is people with asthma and around 180,000 deaths per year are caused by asthma with the most deaths at the age of> 45 years. In Indonesia, asthma falls into the top ten causes of pain. It is estimated that the prevalence of asthma in Indonesia is 5% of the total population of Indonesia, meaning that there are 12.5 million asthma patients in Indonesia [3]. Asthma control monitoring needs to be done so that it can determine the development of the effectiveness of asthma therapy. Besides using treatment therapy, asthma control monitoring can be done through examination of lung function. Changes in variability in pulmonary function can be detected by the value of peak expiratory flow (PEF) measured by a peak flow meter device that can be used for objective measurement of the limitations of daily breathing by patients[1]. Expensive costs and a lot of time wasted when someone has to do intensive treatment due to suffering from asthma. To help reduce the increase in asthma sufferers who are predicted to continue to increase, Peak flow meter devices are needed. With this tool, it is expected to be able to monitor the condition of asthma so that people with asthma can anticipate before asthma recurs. the PEF reading results from 80% to 100% of the normal PEF value are called "Green Zones". This is a normal or healthy zone, there are no abnormalities, a person in this condition can do normal physical activity. The results of PEF readings between 50% and 79% of the normal PEF value are called "Yellow Zones". This is an alert zone, where asthma may attack. Someone is in this condition and can experience coughing, wheezing, and sleep disorders. Someone in the yellow zone must limit physical activity and take medication recommended by the doctor. The result of a PEF reading between under 50% of the normal PEF value is called the "Red Zone". Is a danger zone, which is classified as an emergency condition of asthma. Someone in this condition is usually accompanied by coughing and shortness of breath, and experiencing sleep disorders with a frequency of waking up every midnight and before morning. Someone in the red zone may not be able to breathe in 1 full cycle of breathing. Someone who in this condition must be taken to the hospital immediately to get the right and fast treatment[4]. AT89S51 microcontroller-based Peak Flow Meter (equipped with Normal/abnormal PEFR value) has been made by Devie Muslimatun Nisa, 2012. Weaknesses of the tool still use DC Fan so that the data obtained is less accurate. Then in 2015, a Digital Peak Flow Meter was developed using the MPX5100 pressure sensor by Indah Lindari. The weakness of the tool is that it cannot be applied in data storage. From the weaknesses of the two tools above, in 2017 Ika Safitri developed the tool with the title Peak Portable Flow Meter equipped with SDcard Storage, but the tool cannot classify diagnoses in patients.

Based on the results of the identification of the problems above, the author will make the tool "Peak Flow Meter Equipped with Examination Result Indicator", so that it can display graphs of PEF values and patient examination results in 3 zones, namely red zone, yellow zone, and green zone on PC (Personal Computer) which is useful for knowing the next treatment step for patients

II. MATERIALS AND METHODS

A. Experimental Setup

This study used ten subjects with the criteria the ages ranged between 17 and 25 years old and the height is between 160 to 175 cm for men. And with the criteria, the ages ranged between 17 and 25 years old and the height is between 150 to 165 cm for woman Taking data is repeated three times.

1) Materials and Tool

This study is used as a disposable mouthpiece. MPX5100GP is used to detect a patient's breath Instrumentation amplifier was built based on LM358 OP-AMP. The Arduino Nano microcontroller was used to convert from pressure (kPa) to flow rate (volume/second). Serial cable is used to send data from Arduino to a PC with the UART system.

2) Experiment

The researchers have compiled a module that conditions the signal for the PEF value of the MPX5100GP sensor. The conversion results are sent with serial cable on PC display using Delphi software. Module testing is done by comparing using the Peak flow meter (Rossmax, PF120A). Testing is done three times in each patient

B. The Diagram Block

I When the module is ON and ready to use. Patients will input their identity in the form of age, gender and height through a personal computer. Then the patient blows the expiratory air as hard as possible and immediately through the mouthpiece, making sure there is no air coming out of the mouthpiece. When there is an airflow exhaled by the patient, the MPX5100GP pressure sensor will capture and convert it to voltage. voltage is processed by LM 358 amplifiers and if it is done by the ADC on the Arduino which will be converted into digital data so that the data can be processed in the microcontroller circuit to obtain the peak expiratory flow that will be displayed on the PC via the UART delivery system. And the results of the checks will appear.

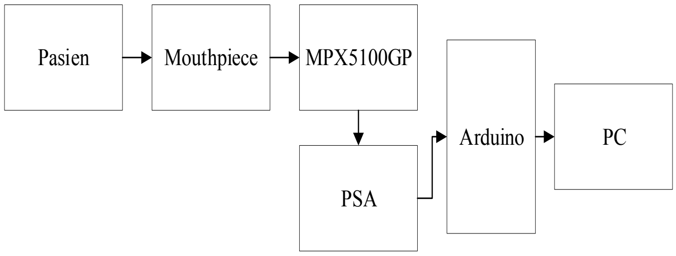

Fig. 1. The diagram block of the Peak Flow Meter

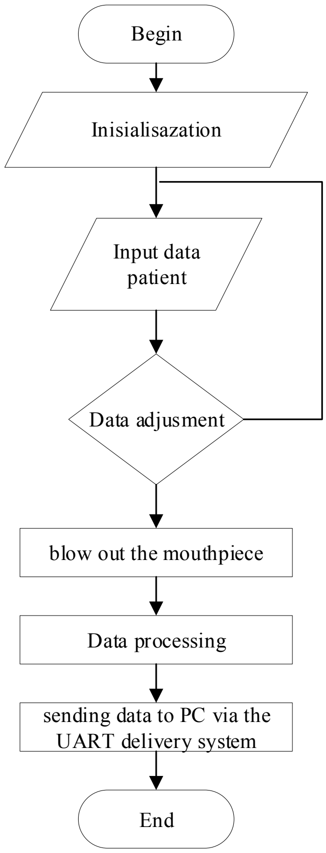

Fig. 2. The Flowchart of the Arduino Program

C. The Flowchart

The Arduino program was built based on the flowchart as shown in Fig. 2. After the initialization of the Arduino, then patients will input their identity in the form of height, age and gender on the PC. When the data is correct, there is an command to blow the mouthpiece, then after the patient blows the mouthpiece the ADC starts processing data from the output released by the MPX5100GP sensor. Then the data is sent and displayed on the PC through the UART data transmission system.

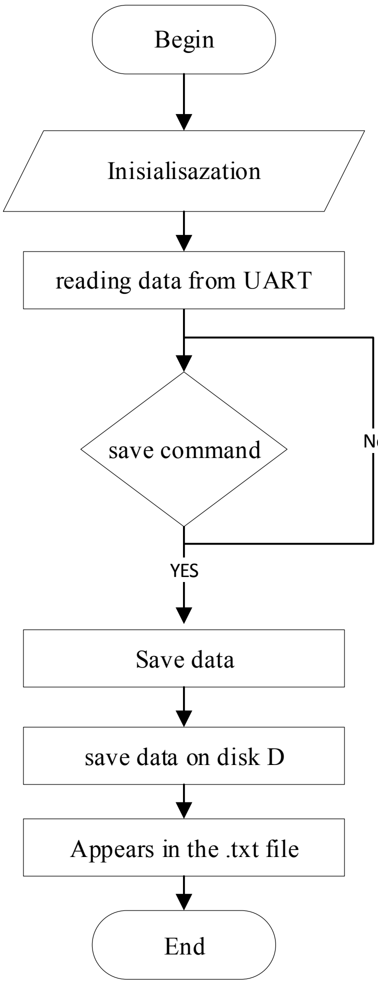

Fig. 3. Flow chart PC

PC reads data from UART. Then the data is displayed on the Delphi display. after completing the PEF test there is a data save command. then the data is stored on the PC driver with the .txt file format.

The important part of this development is the analog circuit which describes in Fig. 4), Fig. 4 (processing signal analog).

1) Processing Signal Analog

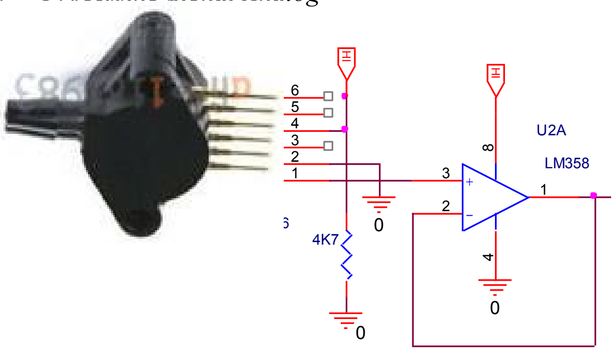

Fig. 4. Buffer Circuit

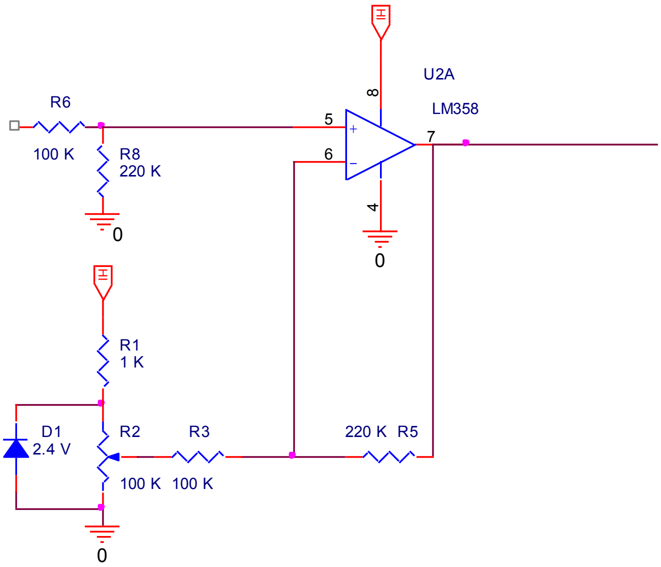

Fig. 5. Differensial Amplifier Circuit

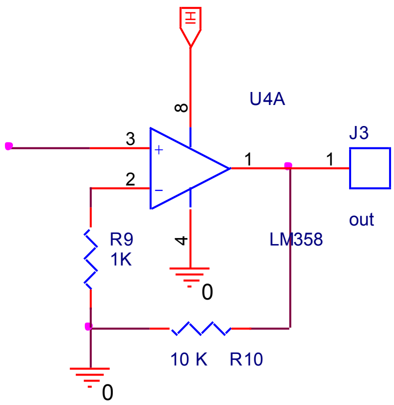

Fig. 6. Non-Inverting Amplifier Circuit

III. RESULTS

In this study, the Peak Flowmeter has been tested using a Peak Flow Meter tool (Rossmax, PF120A) and PEF from the human. The result shows that the recording is feasible to record the PEF from the human.

Fig. 7. The Processing signal analog design

Fig. 8. The Digital part of the Peak Flow Meter

1) The Peak Flow Meter Design

The photograph of the analog and digital part of Peak Flowmeter was shown in Fig. 5 and Fig. 6, respectively. The analog part consisted of two of LM358 (OP-AMP) which each unit composed of two OP-AMP. There was also some variable resistor (multiturn) for gain and offset adjustment. The digital part consisted of the Arduino Nano microcontroller which is the main board of Peak Flow Meter device.

2) The Listing Program for Arduino Peak Flow Meter

In this paper, the software was divided into two sections which are for Arduino and Delphi programming. The listing program for Arduino as shown in the Listing Program 1. Which consisted of the program to convert pressure to volume and send the data to the computer.

Listing program 1. Program to send the ECG data to a computer

```
float tegangan;
float P;
float lv;
float volume;
void setup () {
Serial.begin(9600);
}
void loop () {
int sensorValue = analogRead(A0);
tegangan = (sensorValue*5)/1023;
P = (sensorValue - 0.0875)/0.045;
lv = (P * 0.00314)/1.44;
volume  = lv*60;

Serial.print(volume  ), Serial.println('a');
delay (100);
}
```

3) The Listing Program for Delphi Peak Flow Meter

In Delphi programming, this program is grouped into several parts, namely: a program for Plotting graphs of PEF values into computers, Program Storage (Listing Program 2, a program for storing PEF data into text files, Normal PEF Calculation program and the program determines the results of the inspection indicators.

Listing Program 3. Listing Program Plotting graphs of PEF values

```
procedure TForm1.Timer2Timer(Sender: TObject);
var
  Str: String;
  kpa:double;
//  Count:float;
  nmax1:double;
begin
  kpa:=strTofloat(edit1.text);
  chart1.Series[0].Add(kpa,'',clgreen);
  nmax1:=chart1.Series[0].MaxYValue;
  Edit9.Text := floattostr(nmax1);
end;
end;
procedure TForm1.Button10Click(Sender: TObject);
begin
  chart1.Series[1].Clear;
  Edit10.Text := '';
end;
procedure TForm1.Button11Click(Sender: TObject);
begin
  chart1.Series[2].Clear;
  Edit11.Text := '';
end
```

At the time of the first inspection it will be displayed on the series 0 chart 1

Listing Program 4. Normal PEF Calculation program

```
if (ComboBox1.Text <> '') and (Edit4.Text <> '') and
(Edit5.Text <> '') then
begin

umur:=strtoint(Edit4.text);
tb:=strtoint(Edit5.text);

//===================NILAI PEF
NORMAL===================
pefl := -10.86040 + (0.12766 * umur) + (0.11169 * tb) -
(0.0000319344 * umur * umur * umur);
```

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```
pefp := -5.12502 + (0.09006 * umur) + (0.06980 * tb) -
(0.00145669 * umur * umur);

percent80PEFL := pefl*0.8;
percent60PEFL := pefl*0.6;
percent80PEFP := pefp*0.8;
percent60PEFP := pefp*0.6;
if ComboBox1.Text = 'L' then
begin
Edit6.Text:=floattostr(pefl);
end;
```

The Listing Program 5. was used to count the normal PEF rate from the recorded PEF. The calculation of the nominal value is adjusted for the sex, age, and height of the patient

Listing Program 5. Program to save the ECG data to file

```
//==========SAVE============
procedure TForm1.Button5Click(Sender: TObject);
var
  F: TextFile;
begin
  AssignFile(F , 'D:\hasil.txt');
  Append(F);
  WriteLn(F, '=======================');
  WriteLn(F, '=========Record=========');
  WriteLn(F, '=======================');
  WriteLn(F, 'Tanggal: ',Edit12.Text);
  WriteLn(F, 'Jam: ',Edit13.Text);
  WriteLn(F, 'Nama: ',Edit2.Text);
  WriteLn(F, 'Alamat: ',Edit3.Text);
  WriteLn(F, 'Jeni Kelamin: ',ComboBox1.Text);
  WriteLn(F, 'Umur: ',Edit4.Text);
  WriteLn(F, 'Tinggi Badan: ',Edit5.Text);
  WriteLn(F, 'Nilai PEF Normal: ',Edit6.Text);
  WriteLn(F, 'Nilai PEF Rata2: ',Edit7.Text);
  WriteLn(F, 'Kategori: ',Edit8.Text);
  WriteLn(F, '');
  WriteLn(F, '');
  CloseFile(F);
end;
```

The listing program 5 and 6 were used to save the recorded PEF, respectively. The recorded is in the txt file.

Listing Program 6. indicator listing program results of the inspection

```
if (Edit7.Text <> '') and (Edit6.Text <> '') then
begin

if (ComboBox1.Text = 'L') and (rata > btatasPEFL) then
begin
Edit8.Text:='diatas PEF';
Shape1.Hide;
Shape2.Show;
Shape3.Hide;
end;

if (ComboBox1.Text = 'L') and (rata < btbawahPEFL) then
begin

Edit8.Text:='BERBAHAYA';
Shape1.Hide;
Shape2.Hide;
Shape3.Show;
end;

if (ComboBox1.Text = 'L') and (rata >= btbawahPEFL) and
(rata <= btatasPEFL) then
begin


Edit8.Text:='AMAN';
Shape1.Show;
Shape2.Hide;
Shape3.Hide;
end;
```

When the value of the examination is not in accordance with the normal value, there will be an indication of the disease in the patient. in the form of safe, careful and dangerous.

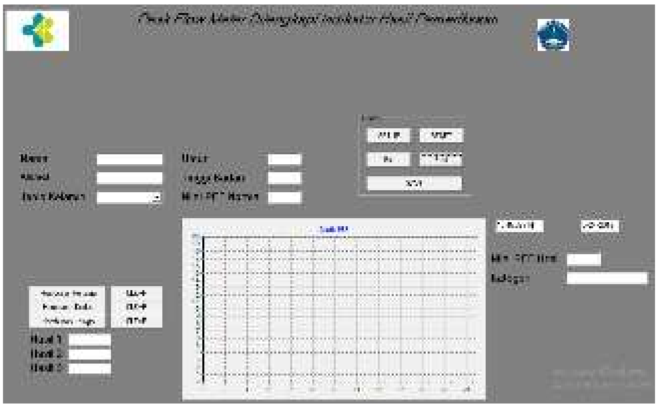

Fig. 9. Display on PC

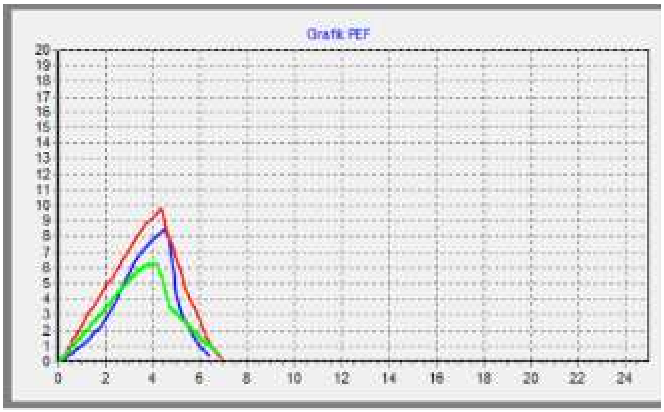

Fig. 10. Display grafik on PC

4) The Error Vout of MPX5100GP

To validate the output of the sensor MPX5100GP, it needs to calibrate using DPM (Digital Pressure Meter). The error was showed in Table I

TABLE I. THE ERROR OF MEASUREMENT FOR BPM PARAMETER BETWEEN THE DESIGN AND CALIBRATOR.

kPa	Error(%)
5	0.27
10	0.14
15	0.01
20	0.02
25	0.23
30	*0.43*
35	0.64
40	0.85
45	1.06
50	1.26
55	1.47
60	1.67
65	1.88
70	2.09
75	2.26

TABLE II. THE ERROR OF MEASUREMENT FOR THE PEF BETWEEN THE DESIGN AND STANDARD UNIT (PEAK FLOW METER, ROSSMAX L120A).

No	Subject	Error (%)
1	P1	1.72
2	P2	2.67
3	P3	0.47
4	P4	2.81
5	P5	1.18
6	P6	1.79
7	P7	0.73
8	P8	0.20
9	P9	2.65
10	P10	1.21

The measurement of BPM value in which the ECG signal is from the human body was also compared in this study, between the Holter design and Pulse Oximetry. The result was shown in Table 2.

IV. DISCUSSION

Calibration testing on MPX5100GP sensor with DPM has been carried out. It can be known that the biggest error value on the sensor is 2.26% at a pressure of 75 kPa. it can be seen that the MPX5100GP sensor can still be used because it does not exceed the tolerance limit of 2.5%. Recording of PEF values to 5 male respondents and 5 female respondents with peak flow meters compared to standard equipment (Peak flow meter, Rossmax). obtained the highest error value of 2.8%. this can be caused by the physical condition of the patient.

V. CONCLUSION

The MPX5100GP pressure sensor can detect airways in humans but is less accurate. This Peak flow meter module has a maximum error value of 2.8%. The value of PEF can be measured in liters/second. The resulting graph is not in accordance with the PEF examination graph on spirometry. this module can be developed using wireless data transmission to be more effective.

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References

[1] A. Lorensia, D. De Queljoe, and K. A. Santosa, "Kelengkapan informasi mengenai cara penggunaan peak flow meter yang diberikan kepada pasien asma di apotek," vol. 1, no. 2, pp. 200–206, 2015.

[2] R. Alimmattabrina, N. Arkhaesi, K. Kunci, P. Expiratory, and F. Rate, "Hubungan Antara Peak Expiratory Flow Rate Dengan," vol. 4, no. 4, pp. 1425–1432, 2015.

[3] F. Zibetra, "Gambaran Nilai Peak Expiratory Flow Rate (PEFR) pada Pasien Asma yang Mengikuti Senam Asma di Pekanbaru," pp. 1–14, 2015.

[4] "Review Article The peak flow meter and its use in clinical practice." .